"A Study of Generalized Functions and Polynomials of One and Multivariable with Applications"

''व्यापक फलनों तथा एकल एवं बहुचर बहुपदों का अनुप्रयोगों के साथ एक अध्ययन''

Revised

Synopsis

Submitted to The

Maharishi Dayanand Saraswati University, Ajmer

In Partial Fulfillment of The Requirements For

The Award of The Degree of

Docter of Philosophy

In

Mathematics

By

Ashok Kumar Meena

Under the guidance of

Dr. K.G. BHADANA

DEPARTMENT OF MATHEMATICS
S.P.C. GOVERNMENT COLLEGE, AJMER
RAJASTHAN, INDIA

SYNOPSIS

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APPENDIX – IV – A

Format for Outline (Synopsis) of Proposed Research Work

(to be supplied in Four Copies)

(Reference Ord. 124.11)

1. **Name of Scholar** (In English) **ASHOK KUMAR MEENA**

   (In Hindi) **अशोक कुमार मीणा**

2. **Title of Research Work**

   (In English) **"A Study of Generalized Functions and Polynomials of One and Multivariable with Applications"**

   (In Hindi) **"व्यापक फलनों तथा एकल एवं बहुचर बहुपदों का अनुप्रयोगों के साथ एक अध्ययन"**

3. **Location**

   a. Institution/Department where the work is to be done:
   S.P.C. Government College, Ajmer, Rajasthan
   Maharishi Dayanand Saraswati University, Ajmer

   b. Geographical area of Investigation, If any : -NA-

4. **Introduction, Importance of Proposed Investigation and objective:**

Introduction: The Topic - **"A Study of Generalized Functions and Polynomials of One and Multivariable with Applications"** has been chosen so that different generalization of well known Generalized function and brief survey of the contribution made by some of the earlier in this field of special function of one and more variables, Integral operators, Integrals and Derivatives of arbitrary order.

It is proved by Abel (1802-29) Norwegian Mathematician that there is no formula to find out zeros of general polynomial of degree more than four as similar to quadratic polynomial $P(x) = ax^2 + bx + c$ a $\neq$ 0, b, c $\in$ R

So study of find out zeros of multivariable polynomials also significant work.

Importance of Proposed Work:- The orthogonal Polynomials such as Jacobi Polynomials, Hermite Polynomials, Bessel Polynomials, Laguerre Polynomials and Several other polynomials play an important role in the study of applied Mathematics and Physics. Polynomials also play a important role in Finite Difference Calculus, Interpolation, Extrapolation, curve fitting, Function approximation etc.

Objective:- Our objective is to generalize their works, specially not only its detailed and systematic discussion of the theory and application of various method of defining and determining region of convergence multivariable Hyper geometric series and functions.

The outlines of the proposed study as follows:-

- A study of applications of generalized special functions in Statistics.
- A study of generalized Mittag-Leffler functions and their applications.
- A study of fractional integral operators and derivative operators associated with generalized function.
- A Study of a new class of multivariable polynomials with it's applications in theoretical physics.
- A study of orthogonal polynomials with Applications.
- A Study of Generating function, Recurrence relations and series expression of various. Generalized special functions.

- A Study of transformation formulas, integrals involving generalized functions of two and more variables.
- Some operational identities, Summation formulas for generalized functions and polynomials.
- A Study of Higher Transcendental Functions and their applications.
- Multiple Hypergeometric functions and their applications.
- A study of orthogonality of various classical polynomials.
- A study of general differential equation for classical polynomials and their application.

5. Review (work already done on the subject of proposed Research study):

The authors who have made significant contribution in this field are Srivastava (1982), Rainville (1907), Exton (1976), Karlson (1975), Erdelyi (1953), Gupta (1971), Pathan (2012), Dattoli (2004), Goyal (1971 C), Luke (1969). Some Indian Mathematician who made significant contribution in this field are H.M. Srivastva., A.M. Mathai., R.K. Saxena., Jeta Ram., D.C. Gokhroo., Chena Ram., S.D. Purohit., S.L. Kalla., R.P. Agrawal., J.C. Prajapati., S.P. Goyal., and some others.

The theory of special functions plays a basic role in the formalism of Mathematical Physics. It covers an extremely wide domain of study (formulated early in the pioneering works of Euler, Gauss, Laplace, Riemann and many others) and continuously refined by new achievements and suggestions. Most of the polynomial functions are Hyper geometric in character and they occur in connection with such matter as physical problems, thus allowing for analytic solutions and hence a deeper insight into the problem under study.

The specific physical problem can suggest investigating new aspects of the well established theory of special functions as well as introducing new functions and other

possible generalizations which usually exhibit deeper features and there by appear again and again in new role in various field of Mathematics. The classical orthogonal Polynomials Jacobi, Laguerre, and Hermite are used in Mechanics, Mathematical Statistics, Mathematical Physics and many more branches of applied Mathematics. Most of these results have been developed on finding critical points of functional by expressing the necessary conditions.

Classical summations' theorems such as Bailey, W.N., Dixon, A.L., Watson, G.N., Whipple, F.W.J. and their various generalization obtain by Lavoie, J.L., Groudin, F. and Rathie, A.K. Results involving hypergeometric series of two variable obtained earlier by Srivastava (1982), Exton (1976), Karlsson(1976a), Dattoli (2000), and Manocha (1966), Goyal (1976), Gupta, (1974) and Quereshi (1984) have studied various special functions and their properties and relations to each other by definite applicative problems and operational identities.

The Topic covered in it included paper on Polynomials and generalized functions; inequalities obtained by use of differentiation and integrations. We used integrals involve the product of Laguerre function of degree α, the multivariable H- function and general class of polynomials with different argument in the form of algebraic functions.

It also give Bessel Polynomials of several variable with integral representation and obtain a partly unilateral and partly bilateral generating relation for this polynomials. Some other results which are generating functions, expansion formulae, single and multiple integrals and fractional integral operators are also used.

We have a multivariable presentation of generalized functions involving products of generalized Hypergeometric functions and then obtain its explicit representation and their various generalization have been studied earlier by Srivastava, Siddiqui, Pathan and several others. On account of the most general nature of the functions and polynomials accruing in various integrals, unifications and extensions of a large number of new and known results.

Motivated by several earlier works establish a fractional derivative of the multivariable H-Function, associated with a general class of multivariable Polynomials.

6. Research Gap identified in the proposed field of Investigation.

There is "No Research Gap" in the proposed field of Investigation. The continuously work done by many researcher's and investigator's in this proposed field of investigation due to wide applications in science, engineering and technology.

7. Major Hypothesis (Chapter wise details of Proposed Research work)

- Introduction and Definitions
- Some integrals involving Generalized functions and Polynomials.
- Generalized k-Mittag- Leffler function and q-Mittag-Leffler function.
- Fractional integration and derivation with Generalized Transcendental Functions.
- Fractional derivatives of multivariable H-Functions associated with general class of Polynomials.

8. Research Methodology –

It is way to systematically solve the Research problem. We study the various steps that are generally adopted by previous work. We use the various generalizations which are communally regards as Hyper-geometric functions and other Generalizations. The Investigation is based either on integral representation or directly on the differential equations. The most effective methods for obtaining Generating Functions are involved series rearrangement. The generating functions Jacobi, Bessel, Legendre, Laguerre, Hermite and many other polynomials. Use of integral and differential operators to find relationship for various class of generalized Hypergeometric polynomials.

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Outline approved

Ashok kumar
Signature of the Candidate with date
15.01.2020

Name and signature of supervisor with date & Seal
Dr. K.G. BHADANA
Associate Prof. (Mathematics)

सम्राट पृथ्वीराज आचार्य
राजकीय महाविद्यालय, अजमेर

APPENDIX-VI

MAHARSHI DAYANDAD SARASWATI UNIVERSITY,

AJMER

Certificate By Supervisor
Certrified that:

1. I am willing to guide the research work of shr/km/smt. ASHOK KUMAR MEENA ..... on the above subject if he/she is registered for Ph.D.
2. To the best of my knowledge, the subject selected has not been studied and is not being studied so far in any University.
3. The subject is of sufficient scope to keep the candidate engaged for two years.
4. The subject will lead to a valuable contribution. I have seen and approved the outline for proposed

   Research work submitted by the candidate.
5. I have .....01.....(give numbers) Research candidates registered under my supervision and the serial number of this candidate whose application is being forwarded for registration is ....01..... (give the serial number)
6. the candidate is not in a close relation (the term of close relation is defined in the examination ordinance fo the University)

09.11.17
Signature of The Lecturer.....
Supervisor with date Samrat Prithviraj Chauhan
Govt. College, Ajmer

Certified that the available facilities will be extended to Shri/Km/Smt. ..ASHOK KUMAR MEENA
.....for research work if he/She is registered for Ph.D.

Signature of prinicipal/
Director of the Institution With date
उप प्रधानाचार्य
राजकीय महाविद्यालय, बांसवाड़ा

10/11/17
Signature of Head of Lecturer.....
Department with date Samrat Prithviraj Chauhan
Govt. College, Ajmer

To,

Date:- 15-3-17

The Principal,
S.P.C. Govt. College, Ajmer

Subject:- Joining of Ph.D course work in department of Mathematics under the supervision of Dr. K.G. Bhadana

Reference:-RET 2016 (M.D.S. University Ajmer)Ref. No.15/research/mdsu/2752

Respected Sir,

With reference to the above subject I have to say that I have been alloted under the supervision of Dr. K.G. Bhadana S.P.C. Govt. College Ajmer for Ph.D. course work by the M.D.S. University (RET 2016). As per the instruction of RET-2016 (M.D.S. University, Ajmer).
I have deposited the requisite fee of Ph.D. course work .
I am submitting my joining report.

Thanking You

Yours faithfully

Ashok Kumar.
(ASHOK KUMAR MEENA)

Forwarded
15/3/17
(Dr K G Bhadana)
(Research Guide)

Forwarded
(Dr. R.D. Upadhyay)
HOD, Maths

Received
Date 15/3/17

राजकीय महाविद्यालय, अजमेर
क्र : एफ-5/अका.1/जीसीए/20 दिनांक .....
.....मि. ई शर्मा (अ.ग्रे.)..... को अग्रेषित की जाती है
.....एम डी एस वि.वि. अजमेर..... को अग्रेषित की जाती है
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उप प्राचार्य 15/3/17
राजकीय महाविद्यालय, अजमेर

महर्षि दयानन्द सरस्वती विश्वविद्यालय, अजमेर

शोध पंजीयन हेतु आवेदन पत्र

विभागाध्यक्ष,
Mathematics
म.द.स. विश्वविद्यालय,
अजमेर।

प्राचार्य,
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विषय:– शोध पंजीयन हेतु आवेदन।

महोदय/महोदया,

विषयान्तर्गत निवेदन है कि विश्वविद्यालय के परिपत्र क्रमांक: एफ–15/शोध/मदराविवि/ 6945 दिनांक 06-10-17 में वर्णित सूचना के अनुसार मैंने निर्धारित कोर्स वर्क सफलतापूर्वक पूर्ण कर लिया है और इस परिपत्र के बिन्दु संख्या–1 में दिये गये निर्देशों के अनुसार शोध पंजीयन हेतु यह आवेदन निम्नांकित वांछनीयता पूरी करते हुए प्रस्तुत कर रहा हूं/रही हूं :–

1. मुझे आवंटित शोध पर्यवेक्षक डॉ. K.C. Bhadana हैं उन्होंने यह आवेदन पत्र मय दस्तावेज अग्रेषित कर दिया है।
2. आवेदन शुल्क राशि रू.500/– का डी.डी. नं. 570117 दिनांक 06-11-17 (कुलसचिव, महर्षि दयानन्द सरस्वती विश्वविद्यालय, अजमेर के नाम)
3. अध्यादेश 124.10 में निर्धारित परिशिष्ठ–IV के अनुसार Format for outline of Proposed Research Work (6 प्रतियों) में वांछित शोध पर्यवेक्षक के प्रमाण पत्र, (परिशिष्ठ– VI) के साथ संलग्न है।

आपसे अनुरोध है कि कृपया इस आवेदन पत्र को संलग्न दस्तावेजों के साथ निदेशक शोध, म.द.स. विश्वविद्यालय, अजमेर को शोध पंजीयन की कार्यवाही हेतु अग्रेषित करावें।

मुझे ज्ञात है कि शोध पंजीयन से शोधोपाधि प्राप्त होने की अवधि में मैं अन्य कोई उपाधि पाठ्यक्रम में प्रवेश नहीं ले सकता/सकती। यदि इस विश्वविद्यालय या किसी अन्य विश्वविद्यालय से कोई डिप्लोमा या सर्टिफिकेट (नियमित/पार्ट टाईम/दूरस्थ शिक्षा) इस अवधि में करना चाहूंगा/चाहूंगी तो वह मैं तब ही करूंगा/करूंगी जब मुझे मेरे शोध पर्यवेक्षक यह प्रमाण पत्र दे देंगे कि इस पाठ्यक्रम को करने से शोध कार्य बाधित नहीं होगा।

संलग्न– उपर्युक्त

दिनांक 09-11-2017

Ashok Kumar, प्रार्थी,

हस्ताक्षर .....

पूरा नाम एवं पता ASHOK KUMAR MEENA
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JAIPUR 303603

टेलीफोन/मोबाईल नं0 8387093080

आवंटित सैवारत शोध पर्यवेक्षक की अग्रेषण टिप्पणी

मैं, डॉ0 K.C. Bhadana इस विश्वविद्यालय का पंजीकृत शोध पर्यवेक्षक हूं। वर्तमान में Lecturer में कार्यरत हूं। मेरी सेवानिवृत्ति की दिनांक 31-07-2029 है। शोध पंजीयन हेतु उक्त आवेदन पत्र मय संलग्न दस्तावेज निदेशक, शोध, म.द.स. विश्वविद्यालय को कृपया अग्रेषित कराएं।

दिनांक : 09-11-17

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